MODIS Science Team Meeting
04-05 May 1999

Plenary Session

Introduction

Vince Salomonson opened the MODIS Science Team meeting, noting that this would be a working meeting with a focus on data products and algorithms. The meeting agenda can be found as Attachment 1. He observed that the meeting was taking place only 12 weeks before the scheduled 28 July 1999 of the Terra spacecraft with the MODIS PFM (ProtoFlight Model) instrument on board, and he suggested that another Science Team Meeting might be held in California to coincide with the launch.

Terra Project Status

Kevin Grady provided a review of the status of the Terra spacecraft (See Attachment 2). The past month has been incredibly busy on the project with three major reviews taking place - the pre-ship review, the launch vehicle readiness review, and the flight operations review.

The Terra spacecraft is now at the launch site at Vandenberg Air Force Base (VAFB) in California. Grady showed a series of photos (see Attachment 3) documenting the shipping of Terra from Lockheed-Martin's Valley Forge, PA facility to VAFB. The spacecraft, in its shipping container, was transported by truck from Valley Forge to Dover AFB in Delaware on April 15, 1999. From there, the truck was loaded on to a C-5 transport plane for the flight to VAFB, where it arrived on April 16. The container was moved into the clean room facility through a temporary airlock structure. The shipping container was opened, and the spacecraft in its shipping bag and bag frame was removed. Terra was mounted onto a Three-Axis Positioning (TAP) device, and a propellant system leak test using helium was successfully completed.

Reviewing the status of the Terra spacecraft, Grady reported that the environmental and systems tests had been completed in August 1998, and that reworked components with enhanced performance had been incorporated into the system. The ground system has been identified as the only system that needs closure. The propulsion leak test was successful, and battery wake-up and conditioning have been completed. The Atlas launch vehicle is on the launch stand, and the launch vehicle ground system is being actively worked, with some additional system testing planned.

The activities planned before launch include final spacecraft testing, loading propellants, spacecraft closeouts, and wet mass property tests. Terra will then be

encapsulated in the payload fairing at about launch minus 30 days and transported to the pad at launch minus 21 days. It will be mated to the launch vehicle, and aliveness tests and launch vehicle / spacecraft compatibility tests will be performed, followed by final closeouts. Spacecraft system power-ups will occur on launch minus 1 day, with the launch itself scheduled for July 28, 1999.

There are still three liens remaining that need to be resolved before launch. There was a lock-up anomaly on the spacecraft SFE; data from this event is being reviewed and it should be resolved within the next week. Demonstration the operational readiness of all ground- system elements needs to be completed. Finally, there is a possibility that the recent Centaur anomaly during a Titan IV launch could impact Terra's launch. A GOES launch scheduled for May 15 will use an Atlas-Centaur vehicle comparable to the configuration to be used for Terra; this should be resolved prior to the GOES launch.

In summary, Grady noted that the spacecraft and instruments are ready for launch, and that the launch vehicle is in great shape, and that everyone is committed to a July 28, 1999 launch.

MODIS Sensor Status

Bruce Guenther next presented a comparison of the Level 1B product expected from the MODIS PFM instrument as compared to the specifications, which is included as Attachment 4. The salient points include the fact that electrical cross-talk on the instrument has been mitigated, with residual effects to be evaluated on orbit. A cross-talk reduction algorithm is in place for bands 5 and 6, as well as for the band 31 light leak affecting bands 32 through 36. The transient response specification will not be met for any of the reflective bands (bands 1-19). The PFM scan mirror is not well-characterized in terms of Response vs. Scan Angle (RVS); the RVS is instead derived from the MODIS Flight Model 1 (FM1) instrument and from PFM and FM1 scan mirror witness samples. Because of the uncertainty on the PFM RVS characterization, the calibration for bands 5 through 7 and 20 through 30 is suspect.

A chart summarizing the status of Level 1B parameters on a band-by-band basis was reviewed. This chart is page 4 of Attachment 3, and will be maintained on MCST's web site. Blocks in white have no applicable specification for that parameter/band combination. Green indicates "no problems", but that should be taken in context. Each PI needs to evaluate the "goodness" of a Level 1B product for use in their algorithms. Yellow indicates areas that MCST needs to better understand - these parameters may not have been measured in thermal vacuum testing, but they should be OK for doing science.

Guenther next discussed the transient response issue. He presented an OCTS band 8 (865 nm) image as an example. The scene shows a region of bright clouds, which normally show as white; a number of pixels in the scene have saturated due to scattering and transient response problems; these show as black.

Scattering moves light from brighter areas to darker areas of a scene. When working with bright areas, with a digital number (dn) on the order of 2000, moving 50dn into the darker areas is a relatively small effect; while for a 200 dn area, adding 50dn is a significant change. Guenther provided examples with scenes containing 20 x 20 km clouds and 120 x 120 km clouds. For most bands, you need to get 14 pixels (about 14 km) away from the edge of the cloud to get clear of scattering effects and get within the 0.5% spec. In high contrast areas where cloud brightness (L_{cloud}) divided by the typical brightness (L_{typ}) is on the order of 20, scattering depends on where in the scene the cloud occurs. When working in the dark part of a high-contrast scene, the science team needs to be attentive to scattering effects. Depending on where in the scene the cloud is, this can significantly impact algorithms that use ratios or differences between several bands. There may also be impacts on the cloud mask algorithms.

Some scene restoration or scene sharpening can be done, but only a small percentage of the total number of scenes per day can be processed. Guenther would appreciate suggestions on how to select scenes for sharpening.

Guenther next reviewed the planned instrument activation sequence. The guiding objectives for this process are to turn MODIS on safely, verify normal functionality, establish accurate on-orbit performance, establish early performance baselines and trends, and to promptly compare pre-launch calibrations with solar diffuser measurements

There are a number of constraints upon the MODIS activation sequence. The spacecraft will not achieve final orbit until day 12, and time is needed for contamination and water vapor outgassing. Door operations are also an issue - the preferred scenario is to open the Nadir Aperture Door (NAD) and Radiative Cooler Door only once. There are also a number of items which must be accomplished within 30 days of first light. These all impact the activation sequence and the availability of data from MODIS.

Counting from launch, MODIS will be turned on on day 7. The space view door will be opened on day 21, maneuvers begin on day 29, and the NAD will be opened on day 34. Days 36-40 will end the activation sequence and mark the beginning of normal operations. Planned major milestones include a first-light image using pre-launch calibration coefficients on day 36, an internal Level 1B (L1B) product using the first calibration coefficient updates at day 49, and an L1B product for use in producing Level 2 (L2) science products at day 76.

There followed a discussion of the Solar Diffuser Stability Monitor (SDSM) and the need for lunar observations for calibration. Because there are no Short-Wave Infrared (SWIR) bands on the SDSM, lunar observations are needed to track Solar Diffuser (SD) degradation in the SWIR bands.

The current plan is to open the Solar Diffuser Door and begin characterizing the SD on day 29 in conjunction with the yaw maneuver sequence. There is some concern that by performing SD observations before the first lunar observation, you won't begin to track SD degradation in the SWIR bands until after the degradation has begun. Guenther noted that waiting until the first lunar observation before exposing the SD to sunlight could cause a delay of up to 28 days in the characterization and calibration process, which would in turn delay the science. There could also be an impact on ground truth campaigns which are being scheduled to coincide with MODIS overflights early in the mission. He estimated that the degradation over the first 30 days would be small - on the order of 0.1% - and suggested that it would be possible to project the SD characteristics backwards if needed for UV-induced degradation. Potential difficulties accounting for single-event contamination were discussed. Guenther believes that the SD door should be opened as currently scheduled, but welcomes feedback from the science team on this issue.

MODIS L1A and Geolocation Status

Jeff Blanchette provided a status report on MODIS Level 1A (L1A) and geolocation code status (see Attachment 5). PGE 01 was delivered in March; some defects in the geolocation routines were discovered which warranted a patch, this should be delivered by May 15, 1999. Land control point matching software has already been developed; Island control point software is in work, and is expected to be delivered in July 1999. Blanchette reviewed the Geolocation Version 2.1 (at-launch) schedule, noting that Bands 1 and 2 in the visible spectrum are used for geolocation. Version 2.2 will be worked on post-launch, and will include MODIS metadata and a robust G-ring algorithm. Issues to be addressed will include geolocation parameter update channels and managing polar wander and leap second data.

Several issues were raised in the ensuing discussion. There was a concern that mappings between Level 1 and level 2 scenes would be difficult, because of the use of G-rings vs. bounding boxes in delimiting a scene. A second concern was over control points for other focal planes - particularly the LWIR bands - given that geolocation only uses visible bands. It is hoped that the internal calibrators will handle this, with the SRCA providing band-to-band registration information. Co-registration issues will need to be worked out by day 49, when the first multi-band scene is scheduled to be produced.

MODIS L1B Readiness and Software Plans

Bruce Guenther provided an overview of the L1B software status, which is included as Attachment 6. He noted that the software has developed in an evolutionary manner, with each delivery based on the previous version. The current version is 2.1.5, which incorporates all science updates received through March 1999. The next delivery is due at the end of May, and will include a number of enhancements, including saturation fixes, a revised thermal band look-up table, a refined uncertainty algorithm, and adding the band 26 Science Data Set (SDS) to night more operations, as well as implementing minor code fixes.

Discussing software testing and delivery, Guenther noted that the L1B software had been tested at a number of different levels, ranging from individual component testing through end-to-end tests at the DAAC. To date, all deliveries have been made on schedule, and MCST has had good experience with deliveries to the DAAC. There is every reason to believe that this will continue with future L1B software deliveries, including the upcoming end of May delivery.

L1B Software after the May 30 delivery will include end-to-end testing, lower level testing whenever code changes are made, difference tests when look-up table changes are made, and science-level testing with MCST generated data sets. Some enhancements to the L1B algorithms will be made pre-launch, most notably improvements in flat-fielding approaches, but no significant changes in the L1B architecture will be made during the remaining pre-launch period.

Post launch, the anticipated L1B timeline (specified as Launch+days) is:

- L+34 to L+49 - using pre-launch calibration values, unstable and unofficial L1B products
- L+50 to L+65 - install on-orbit calibration look-up tables
- L+130 - First L1B workshops
- L+145 - official operational L1B operations
- L+7 months - 2nd Calibration Validation Workshop; these will take place every 6 months thereafter.

Modifications to the L1B code through launch + 7 months will include rapid response changes as needed, low- to moderate- impact changes accumulated during the acceptance and engineering (A&E) period, and frequent look-up table updates resulting from calibration and characterization activities. Current plans also include removing the band 26 SDS from night mode operations at Launch + 120 days unless otherwise instructed. Currently, Band 26 is the only reflective band being operated in night mode. The Computer Resources of MCST (CROM)

will most likely be used to develop and implement these updates; capabilities of these resources were described.

Guenther reviewed a number of non-intuitive aspects of the data file formats for those who might be accessing the data files directly rather than using the readers. These include Earth-registration of data within packets, differences in detector numbering, and the location of band data within the SDS. The existing readers handle these features properly; they should only be an issue for those who access the L1B data files directly.

Guenther closed by reviewing anticipated L1B data volumes, and outlined future version numbering plans.

Goddard DAAC Status for Production

Steve Kempler reviewed the status of the Goddard DAAC for ingest and production processing of MODIS data (see Attachment 7). He noted that the Version 1 system is in production and servicing the TRMM data archive, and that Version 2, which will service the Terra Mission as the ECS, is in development and is expected to be ready in time for the July 1999 launch date. He outlined the projected at-launch data flow, and then discussed the current system status.

The DAAC is conducting a series of Operational Readiness Exercises (OREs) to evaluate the system's functionality and performance, tracking about 59 launch-critical capabilities. ECS Version 4PY is the software build that will be in place at launch; currently, the system has 32 products categorized as "green", 18 as "yellow, and 9 as "red" in terms of functionality; all products are still categorized as red in terms of performance. Kempler notes that red only indicates that the capability has not yet been demonstrated successfully with ECS version 4PY. It is expected that all functions will be categorized as green before launch; OREs will continue in order to resolve functionality and performance issues to accomplish this.

Kempler next reported on the status of the Science Software Integration and Test (SSIT) system, noting the PGE versions currently in operation as well as the expected at-launch versions. He stated that the turn-around time for new versions of science software will be a minimum of two weeks, assuming that there are no problems with the delivery, while patches and code fixes should turn around in several hours to several days, depending on their complexity.

The primary concern with the system is automatic operation of the ingest and production processes. Currently, a fair amount of manual intervention is required in processes that should run completely automatically. Further, documentation for these manual processes is lacking. The mitigation approach

includes working on fixes to the automated system, documenting the interim manual process to be used until the fixes are in place, and working on operator training to ensure proper operation of the system. If automated processing is in place and fully functional at launch, the DAAC will be able to process 100% of the Level 1 products; if manual intervention is still required, Kempler estimates that 70-80% of the products will be able to be produced.

MODAPS Status for Production and Distribution

Ed Masuoka reported on the status of the MODAPS system for the production and distribution of MODIS Level 2, 2G, and 3 science data products. He noted that the ingest portion of the Science Investigator Processing System (SIPS) interface works and that MODAPS is able to receive and ingest L1 products from GSFC DAAC. The integration of at-launch PGEs is underway and should be completed by the end of May, with the exception of the 8-day Atmosphere and 16-day Land products. The acceptance of the at-launch MODAPS system will be completed in June.

Reviewing the open items, Masuoka listed metadata mismatches between MODAPS and the ECS ESDTs, a need for a completion schedule for Oceans ESDTs, a requirement for an operations agreement with the DAACs, network bandwidth issues, and the complete SIPS delivery as issues. He noted that the L1A subsetter is ahead of schedule, but that it uses the Unix "cp" and "mv" commands; a waiver will be required to use these in the production system. The delivery date for the subsetter will be missed if the waivers are not granted. There will be a need to reconfigure the system hardware into the at-launch configuration, which will include upgrading 16 of the processors to 250 MHz CPUs; this will require about 3 days of downtime to accomplish.

An "n-day" production test was run on the current Level 2, 2G, and Oceans daily Level 3 products; the upcoming MOSS-2 end-to-end test will run on at-launch Level 2 and daily Level 3 products. Masuoka discussed the current status of all at-launch PGEs by discipline, reporting on the results from the n-day test and providing a schedule for integration into the at-launch MODAPS system. Details are included in Attachment 8.

The Quality Assurance and Validation resources were next outlined. Available on-line storage is sufficient to hold 100% of L1B 1-kilometer bands for one day, plus 10% of the Level 2 through Level 4 volume for 3 days. There is also 4.3 terabytes of near-line storage available, which can hold up to 12 days of Level 2 through Level 4 products. Network capacity is in place to distribute about 10% of the total product volume from MODAPS to the SCFs, and another 10% from the DAACs to the SCFs for validation purposes. Additional distribution via

magnetic media is also available. In addition, a suite of software packages and a number of workstations are available for validation work at on-site at Goddard.

The tested PGEs fall within the MODIS resource baseline, so the expected 50% production level at-launch should be achievable. The resources needed to make 8- and 16- day products have not yet been measured; it is expected that these will be able to be made at a 25-50% production level at launch. Final production benchmarks will come from the MOSS-2 end-to-end test.
Final benchmarks will come out of MOSS-2

Masuoka next addressed system and software updates. Patches will be first tested on either the development system or the acceptance test system before being applied to the production system. Updates to existing PGEs will take from 1-10 days, depending on their complexity. Implementation of new PGEs may take several months if new loaders are required and if their ESDTs are not registered with ECS system.

The at-launch version of MODAPS will be Version 1; Version 2 is expected at Launch + 6 months. Version 2 will feature faster disk IO, faster loaders, a more robust scheduler, better operator support tools, and a capability to fill in holes in production

In response to a question on delivery times for Level 1B and Level 2 data, Masuoka estimated that 24 hours would be at the high end for Level 1B, while Level 2 would depend on the particular product. He took an action item to get a timeline for the Science Team for data availability.

Goddard DAAC Archiving and Distribution of MODIS data
Steve Kempler provided a status update on MODIS Oceans and Atmospheres data archiving and distribution by the Goddard DAAC, which is included as Attachment 9. Land data will be handled by the EROS Data Center. A series of charts outlining the at-launch data flows and current operational status of launch-critical capabilities was presented.

The biggest concern is the system's distribution capacity. It is currently sized to distribute all archived data once (a "1x" distribution. For comparison, the SeaWiFS distribution capacity is 8x. The full magnitude of the concern will not be known until after performance testing has been completed, but it is recognized that there IS a concern.

A number of steps are being taken to mitigate this, including implementing on-demand subsetting to reduce data volumes, adding additional drives and network capability, implementing browse data products to allow users to order

specific data rather than having them place hit-or-miss orders, and changing the distribution allocation to favor PIs during the first 6 months to allow faster product validation.

The MODIS distribution phasing timeline was discussed. At launch, with ECS Version 4PY running and the DAAC developed ACDIS workaround, about 20-30% of the Level 2 and Level 3 products will be able to be ingested into the Goddard DAAC. ECS Version 5A, which will implement the SIPS interface, will go into operation at Launch +4 months and will bring the production and distribution capabilities to the full 1x level. The distribution of data will initially heavily favor the PIs, with up to 90% of the data going to the MODIS team initially, and ramping down to about 10% after Launch +12 months, with the balance of the data going to general users.

A discussion followed on managing the expectations of the user community with respect to data availability. There will be a demand for early MODIS data products; but only a limited amount of data will be available. Suggestions included producing data samplers to allow the user community to familiarize themselves with MODIS data and how to use it, and articles in the Earth Observer and posters for the IWG July meeting to suggest when products may be available. The Science Team discipline groups will need to take the lead on this effort; information on data availability should be made available on their web pages.

New Millennium RedEye Proposal

Dennis Chesters provided a brief notification to the MODIS Science Team of a new proposal to obtain Landsat-7 like datasets from geosynchronous altitude, called RedEye. This will proposed as a New Millennium project.

EROS Data Center Status for Archive and Distribution

Brad Reed discussed the EROS Data Center (EDC) status for MODIS Land data archive and distribution (See Attachment 10). He reported on a data receipt test, in which 8 MODIS products were retrieved via ftp. The data transfer rate averaged 500 KB/sec, which is somewhat slow, bit it is expected that minor network configuration changes will improve this significantly. One product was successfully integrated into the archive with some manual intervention; the remainder of the products could not be integrated at the time of the test due to problems synchronizing the ESDT's. Full-up system tests will begin after the SIPS interface becomes available on July 15 with ECS Version 5A.

Data will be initially distributed to the public via ftp and 8 mm tape; the data will be ordered via the V0 client. The ECS Version 5B release will support

distribution via CD as well. Issues to be resolved include data release approval and release scheduling, as well as questions of data visibility. Data that is visible in the ECS system is visible to everybody. Reed noted that other instruments use "hidden" servers at EDC in order to test the data products and limit access to the data before it goes public.

NSIDC Status for Archive and Distribution

Greg Scharfen reviewed the National Snow and Ice Data Center (NSIDC) status for archiving and distributing Level 2 and 3 snow and ice data products (see Attachment 11). ECS Version 4PY is running in all three modes; Version 5A is expected in June. NSIDC successfully participated in the TESS exercise, transferring, inserting, and distributing samples of three products. Acceptance testing is ongoing, and participation in upcoming end-to-end and ground system tests is planned.

NSIDC will provide polar-gridded products at launch, with the production volume dependant on MODAPS resources. The grids have been extended to allow for the eventual full coverage of snow and ice areas in the data products.

There are a number of issues in work, including the preparation of a draft operations agreement and an upcoming review of the SIPS-ECS ICD. Other issues include ESDT file mismatches, specification and implementation of a data browse capability, and a disconnect between guide documents and data products. Networks are in good shape, with the EbNET and vBNS systems on schedule.

MODIS Routine Operations

Bruce Guenther presented the plan for MODIS routine operations, included as Attachment 12. Routine operations will commence at about Launch + 120 days. Commanding will be by a 7-day in advance command load, prior to the start of routine operations, a 48-hour command load is used. It is expected that most operations activities will not impact Earth observations; a Field Campaign Form is available in the Operations section of the MCST web page to help avoid scheduling conflicts. MCST will produce a notional schedule for activities that will impact Earth sensing to aid the Science Team in planning campaigns.

During routine operations, there will be occasions where day mode data will be collected at night in order to verify SWIR corrections. Band 26 will not be included in the night mode after Launch +90 days unless the Science Team directs otherwise. Solar Diffuser observations will occur about weekly, and black-body warm-up/cool-down cycling will occur about monthly. A schedule

outlining operational activities for MODIS was provided and is in the Attachment.

MCST will be interacting with the MODIS Science Team in a number of ways. Operations timelines will be posted on the MCST home page; Field Campaign Forms will be available for the Science Team to alert MCST of the Team's needs; Calibration Validation workshops will be held, and code and Look-up tables will be made available via e-mail subscription.

The Calibration Validation Workshops will have several purposes. One is to develop a consensus for calibration changes to be made. Another is to understand the impact of changes to Level 2 products. A set of Calibration-Applicable Archive Test Scenes (CAATS) will be used to test these impacts and make sure there are no surprises in Level 2 products from calibration changes to the Level 1B products. These scenes will often be associated with ground truth sites.

MCST also envisions good communications with the user community. Level 1B data and code will be made widely available, and the MCST web pages will provide information describing the Level 1B products, calibration, and change histories.

Validation and Geolocation

Bob Wolfe described the MODIS Geolocation Validation and Operational QA plans (see Attachment 13). He began with a possible post-launch error trend scenario. At launch, a 0.3-pixel bias error is expected. By about Launch +3 months, the easy bias errors should be removed, cutting the error in half. By the end of the first year, the error is expected to be down to 0.1 pixel. Geolocation errors are given in reference to a notional "Band 0", which in reality is close to the Band 1 location.

Wolfe outlined the geolocation process, which involves instrument characterization, ground control point matching, error analysis, and updating the models used in the production software, with the cycle repeating. Ground control points fall into two categories - Land Control points and Island Control Points. About 6,000 islands, ranging from under 2 square kilometers to about 64 square kilometers in area are used. There is an error of about 500 meters, as the information is derived from the global shoreline database. It is hoped that this library may be able to be updated by MODIS data, resulting in less uncertainty in the data. The land control points will allow a scene to be located to within 50 meters.

Error analysis based on ground control points will identify two classes of errors - biases, which would be caused by measurement errors in determining initial detector locations as well as post-launch shifts, and trends, which may be dependent on the spacecraft's earth-relative location, temperature, and time since launch. These parameters, and others, will be incorporated into the geolocation models.

During the first three months after launch, the focus will be on verifying the Earth location algorithm's performance as operational data becomes available and identify any constant bias terms in control point matching. In the medium term, out to about one year after launch, the emphasis will be on refining instrument alignment knowledge and using control point matching results to identify repeatable instrument-related errors. Beyond that, efforts will be devoted to monitor the stability of instrument geometric parameters and refine the geometric characterization of the instrument based on the longer data record.

Issues and concerns for geolocation include getting good orbit data from the TONS calibration at Launch +26 days, characterizing attitude control in High fidelity mode at Launch +19 days, and verifying conformance to the high-frequency jitter specifications. There is also a need to acquire the remaining Land ground control points; 88 of 126 are currently ready for use. Wolfe reiterated that the geolocation is relative to Band 0, and that band-to-band registration information is provided by MCST.

Validation & Operational QA of L1B

Bruce Guenther summarized planned validation and operational QA activities for MODIS Level 1B products, which can be found as Attachment 14. These were broken down into three categories - 10 Operational Activities, 19 Calibration Activities, and 19 Vicarious Activities. These activities will be mapped into radiometric, spectral, spatial, and other validation studies. It was noted that there is currently no on-orbit method available to validate polarization. The Vicarious Activities will require coordination with field campaigns; specific details to allow on-orbit and field campaign measurements to be compared need to be resolved

Turning to operational QA, Guenther discussed converting radiometric uncertainty into a 4 bit (0-15) scaling index. An exponential scaling function will be used; a series of charts provided the uncertainty values corresponding to each index value on a band-by-band basis. The L1B QA flags and operational daily metrics were reviewed, and an overview of the L1B QA products was provided. The Level 1B QA information is distributed between the core data, granule, and swath metadata files.

Level 1B Radiance Validation
Kurt Thome discussed Level 1B radiance validation (see Attachment 15). He broke the validation process down into several sections - preflight and laboratory calibration work, ground-look methods with ground-based data, ground-look methods with aircraft overflights, and cross-calibration between on-orbit instruments with no ground-based data.

For ground-look data, test sites include the White Sands Missile Range alkali flats area in New Mexico, which is about 40 kilometers in extent; Railroad Valley Playa, a dry lake bed about 15 kilometers in extent in central Nevada; Lunar Lake Playa and Ivanpah Playa, which are smaller sites in Nevada, and Lake Tahoe, on the California-Nevada border. Thome noted that the playas have better reflectance in the infrared bands than White Sands Missile Range.

Thome outlined the field calibration plan, which begins after the end of the ASTER sensor checkout. A series of extended and short turnaround field campaigns are planned, with on-orbit instrument cross calibration filling the gaps between field campaigns. The schedule covers the first two years of Terra on-orbit operations.

A typical extended field campaign schedule covering 33 days was presented. Field work begins at Ivanpah Playa, moves to Lunar Lake and Railroad Valley Playas, continues for 10 days at Lake Tahoe, and then reverses the route, ending at Ivanpah Playa. Ivanpah may be too small at 3 kilometers in extend to support MODIS calibrations, but it can support ASTER and Landsat-7 calibration and validation. The goal is to get the field campaign data out as quickly as possible, and joint campaigns with other groups would be welcome.

Field measurements should be able to provide radiance validation within 5%, approaching 3% in the visible and near-infrared bands, for small-footprint systems. Work needs to be done to determine if this level of uncertainty can be obtained for the much larger MODIS pixel footprints. Additional data points over time should help reduce the uncertainty.

The initial QA volume is expected to be 4 or 5 scenes over the first several months, ramping up to as high as perhaps one scene per day as experience is gained in collecting field data and in training students for field campaign work.

Science System Status
Mike Moore of ESDIS provided a Science System status update, included as Attachment 16. Moore noted that at the last MODIS Science Team Meeting, the Flight Operations System (FOS) was in trouble; it has since been replaced by

Raytheon's EMOS system. This is a commercial off-the-shelf system being tailored to work with the Terra spacecraft; the final build is due by mid-May and is on-schedule.

A list of the ECS Release 4 at-launch capabilities was presented. The system currently has Landsat-7 Level 0R and Terra Level 0 and ancillary data ingest and archive running. Ingest and archive issues being worked include changes in data types and file names from NOAA, SGI D3 server performance problems, and metadata files for some products not conforming to the baseline standard.

Production capabilities for ancillary data processing, MODIS products, MISR Level 1 products, and ASTER Level 2 products have been verified functionally; production performance has not yet been verified. MISR Level 2 science software was not available for evaluation. Issues include contention for critical resources, which degrades performance significantly; this primarily impacts MISR. Patches to reduce contention and system loading are being developed, with MODIS Level 1B software to be updated in June and MISR science software revised through mid-July.

All fundamental search, order, and distribution requirements defined in the ECS baseline have been verified. Database configuration problems prevent some types of searches from working; patches for this are in development. Product order and distribution currently requires workarounds that will not be acceptable under high-volume loads; the June release will fix this. Landsat-7 distribution is running at about 75% due to server failures; patches for this are due in early May.

All fundamental system management capabilities have been verified, including system start-up and shutdown. HP OpenView occasionally requires operator intervention to start or shut down all system components, and occasionally loses track of a component's status; this appears to be a configuration problem, and is in work.

Networks issues were discussed. Network flows and capabilities meet the February 1996 baseline requirements, there have been several significant increases in science team requests since then, not all of which have been met. All mission critical network flows have been implemented as dedicated networks and have been thoroughly tested and meet requirements, Moore specifically noted that 100% of the Level 0 data that comes down from the spacecraft will be captured and archived at GSFC beginning at launch.

There is no policy in place at this point on billing for user data requests; this is in work at NASA Headquarters. Given that the DAAC only has media for data distribution for one year, this is an issue that needs resolving.

Performance issues in work primarily involve distribution. Ingest, archive, and production don't seem to be providing any significant problems. Commenting on components shown in "red" status, Moore noted that these components have all been tested by system engineers, and will work, but they have not been run in operational mode with real operators. There is a training curve for the operators, and a component will not be designated "green" until its operability has been demonstrated.

In response to a question on production and "red" status, Moore noted that performance has been tested by engineers and will work, but red means that it hasn't been run in operational mode with operators. There is a training curve involved. Even if the system will work, it won't be designated green until operability is demonstrated in "operational mode". There are currently about 64 Level 1 and Level 2 trouble tickets, which will be fixed before launch. The ECS position is that for ingest and production, there are no performance issues other than training provided that profiles of science resources required do not vary significantly from baseline.

Bob Evans of Miami noted that network improvements have been significant, but is worried about network bandwidth allocation and apparent limits on throughput at various times during the day. Moore noted that the network interface is controlled by a set of vendors, and that a new contract mechanism is affecting vendor response currently. Improvements are expected over the next several months as the new contractors settle in.

Moore reported that the SIPS interface would be included in the ECS Version 5A delivery. Version 5A is experiencing some schedule problems; if necessary, SIPS will be delivered separately and integrated into the current Version 4PY. The target dates for Version 5A delivery fun from July 15 at EDC to November 10 at the Goddard DAAC; the Goddard DAAC date is driven by the need for a stable production system in place during the instrument check-out system, which runs until launch +104 days.

The results of the TESS system test were presented on a component-by-component basis. Some ancillary data interfaces were not available, and will need to be tested during the MOSS-2 test. Workarounds need to be developed for interfaces that will not be available at launch, such as the ECS SIPS interface. Moore noted that typical latency times for getting MODIS data to the DAAC will be about 24 hours for Level 1 products and an additional 24 hours for Level 2 products.

Early Science and Science Outreach

Yoram Kaufman described the function of the Terra outreach team as to coordinate outreach activity by the PIs through the Executive Committee for Science Outreach (ECSO) and to work to show the advantages of having five instruments show the same location at same time.

David Herring continued with an overview of Terra Project Science Outreach Activities, which is included as Attachment 17. The primary foci of the outreach team will be working with the ECSO, establishing an EOS Rapid Response Network, and managing the Earth Observatory web site.

Herring described the structure of the ECSO, which has 10 members representing instruments on board the Terra spacecraft as well as interdisciplinary members. Each member works closely with 5 EOS PIs, and will participate in monthly telecons to discuss new science results and identify those that are ready for public release.

The EOS Rapid Response network is headed by Jim Collatz, and has a goal to foster rapid turn-around of Terra and Landsat-7 imagery over significant Earth events. The team has a verbal agreement with the USGS Center for the Integration of Natural Disaster Information (CINDI) to share information, and will work to produce data visualizations for release to the public media. There will be several opportunities to test the Rapid Response Network before the launch of Terra, including providing support for a Learning Channel documentary on fire to air in the summer of 1999 and a request for Landsat-7 data to assess changes in glaciers. Work to produce Terra "first light" products and early science results are also in work.

Herring next presented the Earth Observatory web site, which was unveiled at the end of April and can be found at http://earthobservatory.nasa.gov. The structure of the site was described, with examples of the site's contents provided. Other outreach activities were described, including a partnership with the Smithsonian Institution's American History and Natural History museums, work with The learning Channel on a pair of documentaries on "Fire" and "Ice", and the publication of articles in popular magazines. There are also several complimentary web sites, including the Terra home page at http://terra.nasa.gov/ and the Global Fire Monitoring site at http://modarch.gsfc.nasa.gov/fire_atlas/.
Other Outreach activities

Herring closed with a request for support from the MODIS PIs, including a review of the global data set holdings and descriptions, timely notification of significant new science results, field campaigns, and publications, and help with Rapid Response events as they occur.

MODIS Direct Broadcast Data Level 1 Processing System Status
Daesoo Han reported on the status of the MODIS Level 1A and 1B Direct Broadcast data processing system (see Attachment 18). He noted that Level 0 processing, data capture, and antenna concerns were outside the scope of this effort, and that questions on these topics should be directed to Patrick.Coronado@gsfc.nasa.gov.

MODIS direct broadcasting will be in operation 100% of the time, except when the spacecraft is in range of a Deep Space network station. Given a 10-12 minute overhead pass, approximately 1 GB of data will be available per pass. In order to make MODIS data products more widely available, it was decided to make an "official" processing system available to produce Level 1 and a limited number of Level 2 products from MODIS direct broadcast data. The MODIS Direct Broadcast Ground Team (MDBGT) is providing the source code needed to produce these products.

The Release 1 processing system has been tested and is ready for release to the user community. The software was benchmarked on an SGI Origin 200 single-processor system; it processed 5 minutes worth of data in 48 minutes. Improvements in efficiency are expected in later releases. Future work includes incorporating MODIS production software changes into the Direct Broadcasting system and adding additional Level 2 products as a part of Release 2.0.

NOAA Plans for MODIS
Gene Legg of NOAA described his agency's plans for MODIS and MODIS-like instruments, which are included as Attachment 19. NOAA's objective is to look at EOS Prototype Operational Instruments (POIs) to determine their applicability to NOAA's needs in meeting their warning and forecasting obligations. The instruments NOAA is looking at include MODIS on the EOS-AM1 (Terra) mission, MODIS, AIRS, and AMSR on the EOS PM-1 mission, and HIRDLS on the EOS CHEM mission.

NOAA is primarily interested in data from the continental United States and its coastal waters, and will be producing products that correspond to the first 10 PGEs; a listing of these products are available in the Attachment. Data products should be available within 180 minutes of NOAA's receipt of Level 0 data. MODIS data will be treated as operational data, which will be reviewed by Product Oversight Panels. Approval will be required for the routine release of data products. NOAA will release no product before its time.

MODIS PFM/FM1 Status

Neil Therrien provided a hardware status update for the MODIS ProtoFlight Model (PFM) and Flight Model 1 (FM1) instruments (see Attachment 20).

The PFM instrument is at the Vandenberg launch facility, and MODIS test equipment is up and running. Spacecraft-level science checks for MODIS have been completed; there are concerns about the inability to access DAAC-level science data prior to launch. Meetings between SBRS and MCST are scheduled to address this.

The November 1998 thermal vacuum tests uncovered several anomalies in the FM1 instrument, including a power-supply shutdown problem and noise on the redundant side. These problems have been identified and corrected; the noise problem was traced to a wiring error. A thermal vacuum re-test is scheduled for mid-May, and the FM1 instrument completion is scheduled for mid-summer of 1999.

The Solar Diffuser Stability Monitor sun screen indicated a possibility of saturation using the 2% transmittance screen, the screen was replaced with a lower transmittance screen on both the PFM and FM1 instruments.

The FM1 instrument meets the radiometric calibration specifications for the medium-wave and long-wave infrared bands. A Response-versus-Scan Angle (RVS) reverification may be required for bands 29 and 30; however, analyses indicate that RVS is not major driver of uncertainty in these bands.

In the reflectance bands, the FM1 instrument meets the spectral radiance accuracy specification of 5%, but the reflectance accuracy of 2% may be an issue in bands 1, 2, 17, and 18.

Bruce Guenther summarized the improvements of FM1 over PFM, including better polarization measurements, scan mirror scatter quality improvements, an improved NIR objective lens which reduces scatter on the cold focal plane, and the reduction or elimination of light leaks in the system, especially the SWIR light leak from 5 microns and the light leak from band 31 into Bands 32-36.

Oceans Products Status

Bob Evans reviewed the status of the Oceans science products (see Attachment 21). The Version 2.2 delivery reduces the number of ESDTs from over 2000 to about 160. Science algorithms have been updated, and program efficiency improvements have been made. In particular, improvements made to HDF file utilization resulted in reducing the amount of time spent reading the file from 60 minutes down to about 1 minute.

The ability to make products now falls within the CPU resources that SDST specified; it is important to get the new Version 2.2 software into the production system. Evans is confident that the Oceans team will be able to produce good products at launch.

University of Wisconsin Science

Paul Menzel discussed the status of MODIS science at the University of Wisconsin, included as Attachment 23. Updates to the MODIS cloud mask were discussed, and collaborative work with Dr. Wan on surface emissivity and soundings was summarized. This work incorporates surface emissivity into atmospheric corrections, providing better boundary layer characterization for temperature and humidity, resulting in smoother atmospheric profiles between fields of view.

Results from the March 1999 WINTEX field study and a MODIS Vicarious Calibration campaign over the Antarctic Plateau were presented. It is expected that Top-of-Atmosphere accuracies in upwelling radiance over Antarctica should be on the order of 0.05K. Menzel closed with a status summary of MODIS direct broadcast capabilities at Wisconsin. The hardware is being installed, and Level 1 software is being developed; the system should be routinely acquiring data by the end of 1999.

Night-Time 36 Band MODIS data

Jan-Peter Mueller presented a proposal for a new product, using nighttime band 36 data to quantify urbanization. This proposal is included as Attachment 22.

Mueller suggests that it is difficult to detect urbanization from daytime land-cover data due to non-linear mixes of vegetation and buildings, while nighttime lights may be usable as an indicator of socioeconomic status and carbon dioxide emissions. A MODIS night lighting product could be a rich source of socioeconomic information that cannot be collected in any other way.

Muller posits that you can derive population maps from nighttime lights. Correlations between lit areas and Gross Domestic Product and CO2 production should be possible with the use of some ancillary data - the correlations seem to be country-dependent on initial investigation.

Examples of AVIRIS data showing nighttime lights were provided, suggesting that MODIS could readily collect similar data. The 555- micron band just misses the sodium emission band peak. Analyses indicate that MODIS should be able to detect nighttime lights at higher spatial resolution and with better radiometric calibration than is possible with OLS.

Mueller would like to take nighttime 36 band data early on to determine the feasibility of producing new "post-launch" products for URBAN AREA, GDP, and CO2 emission studies. Guenther notes that taking one orbit's worth of this data every other day should not overload the system, and that some nighttime data collections will take place anyway for SWIR calibration.

Oceans Summary

Wayne Esaias summarized the Oceans Breakout sessions (see Attachment 24). He noted that there has been tremendous progress in the MODAPS system over the past 6 months; he emphasized a need to integrate the Oceans products through Level 3 into the system. Subset production for Level 1A data and a Level 1B interface for validation and algorithm improvement are also needed. He suggested that work is needed to prioritize products for early ingest at the Goddard DAAC until the SIPS interface comes on line.

Esaias discussed validation plans, with a validation cruise scheduled off the coast of Mexico from October 1-21. It is important that the launch date be met, a launch slip would result in a MODIS validation cruise with no MODIS overflight data to validate.

Planned early science efforts were described. These will focus on iron limitation for ocean production, fluorescence efficiency, and regional phenomena. Desert dust, which is iron-rich, increases productivity, which in turn draws down CO2. It is thought that the southern Pacific may be iron-limited.

Results from the recent PI Processing meeting were summarized; the need for a waiver on PGE 71 was highlighted.

MODLAND Summary

Chris Justice summarized the MODLAND breakout sessions - see Attachment 25. He noted that data system issues dominated the discussions. The Land group will continue prototyping QA data for the n-day test. There is a concern about the ECS Version 5A delivery to EDC occurring at the end of August, there will be problems if this delivery is late. He suggested that user services coordination is needed.

Tiles have been selected and the aerosol dependency has been resolved for the 50% Land Production plan. The tiles will be at full resolution, and individual additional tiles can be selected to accommodate field campaigns.

An integrated land schedule has been developed, combining the MODLAND production, QA, and Validation timelines. A strawman proposal for Land early products and images was presented.

Validation opportunities and resources were listed, including an ER-2 February 2000 flight, SAFARI 2000, LBA, and FLUXNET. The Land group needs to work with EDC on getting 1-kilometer AVHRR data for validation. Closer links with other sensors are needed in order to perform cross-calibration, validation, and multi-sensor science.

MODLAND would like to request a schedule for nighttime data collection of Band 1-4 and 8-14 data. They suggest an Early Products meeting at about 6 months after launch to focus on how users can get data, talk about product quality, and propose improvements in the data. A Science Results meeting would follow at about 12 months after launch.

Esaias seconded Justice's remarks on early science. He noted that since no reprocessing is being planned, it is important to get early calibration and validation done to get the parameters RIGHT. This would provide 2 months of good data by launch +6 months.

Closing Remarks

Vince Salomonson closed the plenary session, noting that the teams seemed to have covered all the issues well, with a general feeling that the overall status is good. He found the schedules laid out by the groups to be well-done. He indicated that he is very supportive and enthusiastic about early products meeting in the launch +6 month timeframe.

After announcing that the next meeting would tentatively take place near Vandenberg within 3 days of the launch of Terra, Salomonson declared the meeting adjourned.

MODIS Oceans Discipline Group Meeting
3-4 May 1999

Preliminary session: May 3, 1999

Wayne Esaias convened the MODIS Oceans Group meeting at 1:30 pm on May 3, 1999, one day prior to the start of the MODIS Science Team meeting. The purposes of the session were to go over unfinished business from an earlier Oceans Group meeting in Miami, and to get together with the support teams to work out a data product strategy for launch.

The first order of business was a review of the Ocean Validation Plan. The input to date had been assembled into a draft document, and Esaias planned to finalize it and submit it before the end of the Science Team meeting. Plans and logistics for several upcoming campaigns were reviewed, and a suggestion for listing individual investigators' web pages for locating validation plan information was made.

Esaias noted that all but 2 ATBDs had been submitted, and that a July 28 launch date was looking solid.

Bob Evans reported that the opportunities for code changes was closing, and provided a team-member by team-member overview of code status. Changes to coefficients are categorized as table changes rather than code changes, and will continue to be implemented as needed. Bob Woodward noted that the April 23 code delivery needs to be integrated in the at-launch processing system, and provided an overview of each product's readiness for integration into MODAPS. A complete suite of products will be coming out perhaps by the second or third week of May.

The Oceans PGE readiness chart shows some PGEs still in condition "Red". This is because there's been nothing to run through these processes yet. Once a full suite of products is available and running, MODAPS can work on process efficiency and exercising the rule sets.

SeaWiFS data has been run through the MODIS processes, initially to make sure that processing could be done, but also to look at the results to see if output products from the algorithms make sense. The reflectances and radiances produced by the algorithms look reasonable; the team should be able to concentrate on instrument characterization rather than code validation early on in the mission.

DAAC archiving was discussed next. If MODAPS works as planned, it will produce more than the DAAC can ingest until the SIPS interface is in place for automatic ingest. Data will be placed on a MODAPS server for the DAAC to "hand-ingest" until then. The plan is to keep products produced at Level 2 down to about 20 GB/day; product prioritization was reviewed. It was noted that the DAAC is still working to the February 1996 baseline data product levels of 64 GB/day, which differs from the expected MODAPS production levels of 200 GB/day; this needs to be resolved.

A discussion on product release strategy followed. One issue is whether data will be made public immediately or at the 120-150 day "official release" date. There is some uncertainty over when the clock starts for the 120-150 day period. There is also some concern over the quality of the early products as the instrument is being characterized and the algorithms validated and refined. While QA flags exist, it is not certain that users will take note of them, which may result in their forming an unwarranted unfavorable impression of the Oceans data products. A practical consideration on product release is the volume that the DAAC can handle early on. It is expected that initially 90% of the distribution capability will be dedicated to the MODIS team and the remaining 10% to the general user community. This will reverse by launch plus one year in accordance with NASA policy that there can be no discrimination between the scientists and general users in data distribution.

A brief discussion of browse files followed. Browse files will consist of low-resolution images along with limited metadata (time and location) which will allow a user to order data. The images are not sufficient for doing science. The question of whether Sea Surface Temperature should be included in the browser set arose. The DAAC can generate a browse image out of Level 1B data, but would need MODAPS to produce a Level 2 browse product and feed it back to the DAAC. Possible browse products for both day and night cloud cover detection were discussed. It was noted that the current system allows a user to search for and order data, but that no system for delivering the data is in place. This is in work.

A potential problem stemming from the fact that metadata is polygonal for low-level data but rectangular in higher-level data was noted. This may result in a location specification returning different scenes for different product levels. The use of compression in MODAPS files was also discussed. While the ECS toolkit will not handle compression, the toolkit will not be ready for use early on.

Jerry Goddin from MCST reported on L1A/L1B calibration efforts. He noted that validation activities are being organized into 3 groups. OAs - operational activities - are integrated with other spacecraft and instrument activities. These are generally well-planned out, and are difficult to change. CAs are

characterization activities; the SRCA is an example of a CA. VAs are validation activities - the actual field campaigns. MCST would like to integrate the MOCEAN validation schedule into the MCST cal/val VA program. Goddin notes that there are about 20 OAs and 15-20 CAs currently defined

The October 1999 Baja California initialization cruise was next on the agenda. Esaias expressed a desire to make sure that the instrument/spacecraft operations group won't be doing any maneuvers, etc during overflight of campaigns. A change has been proposed to delay opening solar diffuser (SD) door - some want to wait until lunar looks are done before starting the degradation of the SD by exposing it to sunlight. The current plan is to take data from the solar diffuser both before and after Nadir Aperture Door (NAD) opens in order to map diffuser - there may be may be SD port scatter effects. This is a new issue, and Esaias indicated that it needed discussion in the plenary session. The first data is expected on day 30, while the lunar look is planned for about day 60. As the lunar look requires a series of maneuvers to look through both the SD port and the earth view port, data collection from MODIS during the validation cruise may be impacted. This may impact validation cruise. Additionally, the recent Atlas launch failure might impact the Terra launch date, which could again impact the validation cruise. Since the October 1999 cruise was scheduled for both SeaWiFS and MODIS validation, minimizing the impacts of operations on data collection during MODIS passes is highly desired.

David Herring provided a presentation on the Earth Observatory and Terra outreach activities (see description in the plenary session minutes), after which Esaias adjourned the session.

Breakout Session: May 4, 1999

Esaias reconvened the Oceans Discipline group on May 4, 1999. There was no agenda for the session; the purpose was to react to what had been discussed in the plenary session.

Concerns over funding availability for validation operations at the fiscal year boundary were raised. FY 1999 ends 30 Sep 1999, and FY 2000 funds will not be immediately available for the October-November timeframe. A need for a variance on the funds carryover policy may be required due to the timing of the launch.

The need for promoting reasonable expectations on data product availability was discussed. Data processing for a full product suite will not be available initially, and there is a potential for problems not unearthed using synthetic data to emerge when real data begins flowing through the system. There may be a need

for MODAPS to have an expedited system for accepting and incorporating science code updates during the first 6 months of operations.

Bob Evans raised the issue of network bandwidth allocation; there seems to be artificial constraints in place on network access. The lines of communication to the network group do not seem to be in place for handling inquiries and taking action to resolve problems.

A waiver is needed for using the UNIX "cp" and "mv" commands in order to implement L1A subsetting; failure to obtain these waivers will result in subsetting not being available for launch.

Vince Solomonson expressed some concern about transient response, and noted that the point spread function is better than SeaWiFS, but the focal plane is larger. He inquired whether the ocean team would prefer to launch on schedule or wait 3 months to resolve the issue; Esaias noted that oceans was committed to an October validation cruise, and therefore favored launching as planned on 28 July. It was noted that the cruise could use SeaWiFS or AVHRR data for information on fronts and other environmental conditions, and that MODIS was not required for daily operational work during the cruise.

Bruce Guenther noted that the first Level 1B characterization information comes at about day 64, which corresponds to the start of the cruise. This information could be applied retroactively to earlier data, but Guenther is unsure how to process that through the DAAC. There is also a need to get the May 30 Oceans delivery down to Miami; the mechanisms for making that happen are also unclear.

The need for a storage plan for Oceans Data was discussed. Also mentioned was a desire to accommodate the SIMBIOS team's interests using MODIS Oceans data products.

A set of "standing orders" for data products to be delivered to Oceans team members needs to be set up with MODAPS. These should be in the form of memos of Understanding with Ed Masuoka, with copies to Wayne Esaias.

Otis Brown raised a concern over no geolocation tests being performed at night; there may be bending and pointing changes between day and night operations. Guenther expects that the spacecraft team will be able to provide good information on moments, and that MCST will be able to provide good warm to cold focal plane co-registration information. Cold vs. warm co-registration can be run up to 30 times per orbit, and will be run for a 3-4 orbit period early on in the mission.

Support for a Calibration/Validation workshop in the January timeframe emerged after some discussion.

Esaias summarized the Oceans concerns to be transmitted to the MODIS team during plenary session, and adjourned the Oceans Discipline Group meeting.

MODIS Land Group Meetings
4-5 May 1999

1.1 Introduction

The MODLAND Meetings were chaired by Chris Justice and minutes were taken by David Herring. In the 4 May meeting Justice focused group discussions on preparing materials to report back to the Plenary Session of the ongoing Science Team Meeting. On 5 May, the group focused on QA updates and issues. Justice also received reports on the SCF's plans to contribute to QA; e.g., how much data will they examine in the first few weeks / months after launch? Justice said he wants to "manage expectations" for folks who expect to go to the DAAC for data shortly after launch. In the 6 May meeting, the group discussed validation (however, Justice elected not to record the minutes of that discussion). Justice reminded the Land Group of the action item from the last meeting to focus on the MODIS N-Day Test. He wants to produce an integrated timeline of all testing, integration and N-Day tests in the pre-launch timeframe. Regarding outreach, Justice asked Herring to explore possibilities for NOVA or National Geographic to produce a TV documentary on SAFARI 2000.

1.2 MODAPS N-Day Test Evaluation

Robert Wolfe gave an overview of the MODIS N-Day test, which was supposed to be a 3-day test in which MODAPS produced 8-day and 16-day products. The test started a week later than scheduled and MODAPS experienced problems with its database. When the test started, it went slowly due to operational problems and produced only 2 days of data. MODAPS did get data into the QA database, but initially it was received sporadically. Toward the end of the test MODAPS was receiving a daily feed of data, which gave SDST an opportunity to see most of the Level 2 MODLAND products in operation. Zhengming Wan's product was the exception because extensive engineering tests were being done on his PGE during that period.

After the N-Day Test, SDST started preparations for the Terra end-to-end (ETE) test. Problems were found in the metadata caused problems, so SDST had to modify the metadata. There are also fixes to the metadata required on DAAC & ECS side.

Regarding ordering of products for the N-Day and ETE Tests, SDST had success. Yet, Wolfe reported, ordering data from GDAAC or other DAACs is not happening right now. When Eric Vermote tried to order Level 1A and 1B data, he received some notifications, but when went to get data he found that the server wasn't up and running. That issue needs to be resolved. Also, Wolfe said, the interface is clunky—it takes 15 minutes or so to order a product. He said a

workshop was held to evaluate the interface and there were about 30 suggestions made to improve the interface.

Wolfe summarized the goals of the N-Day Test:

- One goal was to identify any bugs in the system. No new ones were found, but some previously-identified ones still remain.
- To do a lot of production prototype planning.
- To prototype QA procedures and test the QA database.
- To test the SCF interface.
- To identify bottlenecks in system performance—no bottlenecks were found. However, SDST now needs to try now to push more data through system.
- To assess the performance baseline from PGE & production. A lot of PGEs are coming in under allocation, which is good. There is a problem, however, in overall performance—2 days of data in 3 weeks is not good (about 10%).
- To test the process for introducing patches into the science software in MODAPS.

Justice asked the Land Group how many people looked at those N-day test data? Half a dozen or so folks responded affirmatively. Justice asked if those data should be put back online? Wolfe pointed out that the N-Day Test is not over, it is still running.

1.2 MODAPS Assessment

Vermote presented an overview of the recent MODAPS tests. He reported that the MEBS WILT is done. He is pleased to see that the previous bottlenecks were fixed. The N-day test is done (Version 0 MODAPS), but he is still doing analyses. Nazmi El Saleous is backing up the data onto a database and he can produce 8-day products before the next meeting.

Vermote announced that an X-Day Test is upcoming on the operational system (Version 1 MODAPS). This test, scheduled to run from 8 May to 4 June, will enable assessments of the at-launch version of MODAPS. Vermote said preparations for the test are running behind schedule.

Terra's TESS is done. That includes the Version 0 system, which is MODAPS + TESS.

The goal of the X-day test is to start from Level 1 and produce products through Level 4. Vermote said emphasis will be placed on producing 8-day, 16-day, 32-day and monthly data products. He will test the reduced production (50%) operations scenario. The new Level 1B format and new synthetic data will be tested, as well as the updates (patches) of PGE's. Vermote said he is also preparing for MOSS-2 (he has already received some data from the GDAAC).

Wolfe said SDST needs to conduct some operations exercises in which it is receiving data.

Regarding the MOSS-2 test, the Terra test was originally to be a 1-day test, but it lasted a week. Vermote coordinated an ETE test of product flow, including the following interfaces:

1. EDOS -> DAACs -> MODAPS -> DAACs;
2. MODAPS -> Science Team distribution;
3. DAAC -> data users; and
4. Science Team -> DAAC (for QA updates)

Vermote reported that the GDAAC archive and distribution system is not yet operational. The 5A software delivery is coming at the end of June 1999.

Justice stated that the crux of MODIS' success is whether or not folks can get data. Wolfe responded that SDST will do manual inserts at the DAACs. The science team should be able to order data, but the matter of sending QA data back is still a concern. Justice said another issue is getting the results of the N-Day test back online so folks can exercise their QA routines. The Land Group still hasn't produced 8-day products. He asked Nazmi El Saleous to create a schedule for doing that.

Wolfe observed that there is a lot of emphasis from the GDAAC on getting data and preparing for MOSS-2 test and coordination across DAACs and instruments. There are a lot of software and data tests going on simultaneously. He said it will be difficult to track everything and give feedback in a timely manner.

David Roy said he would like the Land Group to begin thinking about what production and QA assessments will be like after launch. Specifically, what will they be doing? Roy is concerned that he doesn't see the Group members making those plans. He is particularly concerned that because the schedule is being compressed the QA routines won't be planned and executed properly. Justice suggested that MODLAND could conduct a small 2-day workshop prior to launch to determine exactly how the Group wants to work data production and QA issues. At that time, the Group will address issues of how to practically move forward. The idea is to have an "all hands on deck" meeting so everyone can participate and be aware of timing and scheduling expectations.

1.3 Review of Action Items

Justice reviewed action items from the last MODLAND-SDST Meeting and asked attendees to report on their status:

1. MCST to modify PGE02 code. **Status**: Done.

2. Guenther to draft a plan for MCST validation & first release of data products. **Status**: Done.
3. MCST & MODLAND to interactively prioritize the list of MCST instrument performance studies for MODLAND. **Status**: Guenther said MODLAND needs to produce a list of priority things from MODLAND's perspective for MCST to consider. He said the issue of transient response needs to be on that list.
4. George Riggs to get together with Gerry Godden to evaluate the dark target edge assessment tests. **Status**: Hall said no one knows what it will be like. Leads in the sea ice will be a good test for edge assessments. When she gets those data, then her team can do the assessments. Justice asked if those tests have been designed? What sorts of things would Hall like done in those tests? Has the tile been identified? Who will do test? In short, he asked Hall to begin planning it in detail; he doesn't want to wait to address this problem after launch. Godden said there is an issue regarding the location of bands. He said the data you're collecting should look for effects that are overlooked with respect to the location of bands and field stops. He said MODLAND should be specific about tests, and be sure to specify which bands it plans to use. He feels the tests should be rigorous.
5. Guenther to publish a schedule for practicing generation of CAATS scenes. **Status**: Guenther said this schedule will probably be produced no earlier than June.
6. Sol Broder to coordinate the interface between SDST and NOC (GSFC's Network Operations Center). **Status**: Broder noted that NOC is an institutional resource for NASA; it is therefore hard to get them to work specific interface issues with SDST. He said the NOC will write an interface plan and submit it to SDST for approval.
7. Broder to take initiative to work through each MODLAND PI group to begin sending data thru MODAPS in tests that will give some results on end performance. **Status**: Broder said there is a security issue involved with the NOC. Justice said he sees the issue differently. The NOC seems to be willing to talk, but tests to send real data would have to be in SDST's domain. Justice said it is up to Broder to get outside support for that. Broder said the NOC hadn't subscribed to doing tests between the SCF and MODAPS. Justice asked if Broder needs help from SDST to work this issue? Broder said no, but it will take him a need week or two to resolve it. Jan-Peter Muller said the first issue is completing SCF-to-SCF connections to facilitate ordering data via the Internet. He noted that Web browsers tend to route data differently than File Transfer Protocol (FTP). If the SCF decides to use the Web, then it needs to ensure speeds that are comparable or better than FTP speeds. The current speed via the Web interface is unacceptable.
8. David Herring & Jim Collatz to work connections between the Terra Project Science Office and MODIS discipline teams for public outreach. **Status**: Herring responded that the issue is being worked. He is planning a joint

teleconference to include all MODIS Discipline leaders, as well as all instrument PIs, to discuss strategies for producing and publishing Terra's first images, as well as facilitating an ongoing rapid response capability. Herring added that MODIS discipline contacts have been identified for rapid response—MODLAND=Eric Vermote, Atmosphere=Bill Ridgway, and Ocean=Bob Evans.

9. MODLAND members to report on any plans to participate in LBA field work. **Status**: Huete said if anyone is going to Brazil, there are special visas needed. To go, team members need 1-to-1 interaction with a Brazilian collaborator. Justice said he strongly advocates interaction with the LBA field campaign. He asked if Steve Running is willing to broker a MODIS data conduit down to Brazil.
10. MODAND PIs to specify their needs for Landsat 7 data through Jeff Morissette. **Status**: Open.
11. Zhengming Wan to resolve Lunar Lake (aircraft) plans and communicate with Bruce Guenther regarding his plans for thermal vicarious calibration. **Status**: Open.
12. Wim Van Leeuwen to recommend how to register MODIS to MQUALS data. **Status**: Open.
13. Jeff Morissette to feed in South African validation sites for cal/val of EO-1. **Status**: Open.

1.4 Early Data Production Planning

Wolfe showed the MODLAND production timeline. He expects tests to keep going after launch until first receipt of data. He is working with ECS and the DAACs to ensure data will insert the first time they are sent. Level 1 products will be produced at the GDAAC about 1 month after launch. Joe Glassy noted that the 5B drop is driven by the DataAssimilation Office's drop.

Wolfe showed MODLAND's Overall Timeline chart and QA timeline chart. He said the QA database is almost done, but it still needs some tweaking. From two to six months after launch, SDST will focus on finding and fixing problems related to production of data products. During months six through twelve, SDST will focus on documenting product quality and improving the science code. That time period is also when first reprocessing will begin.

Wolfe showed the MODLAND validation timeline. Justice wants timeline modified to show events, not continuous activities. He asked the MODLAND Group to feed any plans for validation or QA campaigns to Robert Wolfe, Jeff Morrisette, and David Roy.

1.5 Initial PR Plans and Expectations

Justice discussed MODLAND's strawman plan for early publication of MODIS data. He solicited ideas for early production of MODLAND products for

visibility and PR, as well as validation. Running advocated choosing some previously acquired sites and really demonstrating the improvements of MODIS over AVHRR.

Justice said some daily products will come out, such as vegetation indices, snow cover, fires, etc., for some tiles. These should be processed to the point where they're visible and acceptable. Then the Group would move toward producing multi-temporal products. Then MODLAND will work out true color products. Then the Group can compare MODIS' products to AVHRR's and Landsat's. Justice said there are many different levels of early products. He feels the details must be worked now.

Townsend said the Group must consider for whom we are doing PR. He distinguished between the remote sensing community who knows what AVHRR stands for, and other audiences who are scientists but who don't know about our data products, and then there is a still broader audience that is just fascinated by new images. Herring felt that in the early days shortly after launch, the first images will not really be science data products, but will primarily show false color representations of "high" to "low" levels of a given parameter.

1.6 Quality Assurance Updates and Issues

1.6.1 The 50% Rule Versus Adding New Tiles

Muller stated that as part of a consortium, we have Mediterranean partners doing cal/val as well. So, he would like to add the tile of Northern Spain to the other tiles currently planned for processing to higher level products in the first year after launch timeframe. A lively discussion followed in which the Group was reminded of its anticipated limit to be able to process only half of the data beyond Level 1. Hence, adding new tiles is a "zero sum game." There was discussion about trading an existing tile for Northern Spain. Running asked if the Group would be better off processing the whole world but only half the time? Justice responded negatively, stating that MODLAND held this discussion previously and decided against this approach. Alan Strahler felt that the 50% plan doesn't really show us what our actual processing capability will be at launch. He said adding one tile isn't really a zero sum game yet because we won't know our processing capacity until we know, so there's no reason to not add one more tile at present.

Hall asked whether tiles over high-latitudes will be added so her team can process its sea ice products. If not, we won't have any sea ice data in the first year or so. Justice asked Hall to produce a plan in her SCF on how to handle sea ice. Wolfe said he would work with Hall on that plan. Justice pointed out that the strawman doesn't prevent folks from running tiles in their SCFs. Wolfe proferred that once the Group is receiving data, it can rethink its priorities then.

1.6.2 Early MODLAND Products

Justice listed the strawman plan for early (L+12 months) MODLAND products:

1. First MODIS Image (w / pre-launch cal)
2. Land Early Images (Launch to L+3 months)
5. 250 m surface reflectance / Color (2 dates where possible)
6. 500 m true color
7. Vegetation Index (VI) (single date special product)
8. Enhance Vegetation Index (single date special product)
9. Surface temperature (daily product) — continental product 3 months after launch
10. Active Fire (South Africa, Brazil)
11. Snow Cover (Arctic) — Hall plans to produce climate model grid shortly after launch for whole globe.
12. Land Cover
13. Bidirectional Reflectance Distribution Function
14. SeaWiFS comparisons
15. Images of Opportunity – Points of Contact are Eric Vermote, Jon Dwier (at EDC), Greg Scharfen (at NSIDC), and Jeff Morissette for validation.
16. MODIS Global Image – at reduced resolution

1.6.3 MODLAND QA Update

David Roy presented an update on the LDOPE QA. He reported that the LDOPE continues to develop QA tools. He is currently concentrating on studying interdependencies between products. In the LDOPE QA database, Roy recently implemented the new functionality requested by Joe Glassy. He noted that the database is being migrated to a Sybase version and is running a lot faster. Roy expects the Science Team's tirekicking of database to continue under the X-Day and Y-Day tests. He gave the URL for the MODLAND QA web page — http://modland.nascom.nasa.gov/QA_WWW/qahome.html.

Regarding PI Processing of the N-day test, Roy found problems with the MEBDOS interface—he feels it is not very good. He is also finding metadata "valids" that are not correct. He reported that there have been about 7000 QA logs into LDOPE QA database and 198 granules have had their QA flags changed so far. He said this shows that not many people are playing with the system. He concluded that the LDOPE needs to keep doing this on ongoing basis.

Roy reported on the status of ECS QA-Related Functionality. He noted that the DAAC Data Order V0 WWW drop 5A supports searching against ESDTs, spatial and temporal parameters, local granule ID numbers, and science quality flags. Drop 5B supports searching against all remaining core and product-specific metadata.

Roy summarized the early product QA schedule. Months 2-6 (August 99 – January 2000) will be spent identifying problems related to individual products and those related to dependencies between products.

1.7 MODLAND Reports on QA Expectations and Plans

Justice asked each MODLAND PI to present QA expectations and plans.

- Surface Reflectance – Eric Vermote said he will use coarse resolution to screen for problems and to identify areas for full-resolution analysis. He will locate anomalies by inspecting the validation sites statistics. He will check LDOPE QA database to obtain the status of upstream products and to locate suspect granules. Regarding the Level 3 coarse-resolution product, Vermote will compare to SCF Level 3 coarse-resolution product and locate tiles that need further investigation by interactive inspection. Regarding the full-resolution QA analysis tool, he will interactively order 2-3 tiles per day, as well as Level 2 granules when needed. David Roy asked what if all checks indicate the product is "crap"? Vermote said he will then rerun that code at Level 1b. Roy suggested that he should also contact the LDOPE to tell them so can go work the issue with MCST.

- Land Surface Temperature – regarding pre-launch activities, Zhengming Wan said he is still learning. He is now adapting to the LDOPE toolkits, and developing LST-specific tools. Regarding post-launch activities, Wan will produce LST for the polar regions. He plans to compare day and night LSTs over different regions, do temporal analyses of LST over large lakes, and correlate between LST & NDVI. Roy asked what is the relation between Wan's plans and validation? He asked what kind of data volume Wan expects in the first 6 months after launch? Wan said it depends; initially probably 3 percent for each activity. He has a student assistant working on the first part of his plan. Roy pointed out that reviewing these products is very time-consuming. He recommended Wan get additional student assistance to help with QA. Justice added that Wan needs more details on what he actually plans to do. Justice feels that the LST QA plan is not mature enough. For instance, there is no operational QA plan.

- Wim Van Leeuwen presented an overview of the MODIS Vegetation Index products. His team will take 30 GB of input data and produce 300 Mb output products for 16-day periods. The ratio is output equals input divided by 100; or roughly 5% which will result in 15 tiles produced every 16 days. He plans to do continuous trend analyses for validation sites using subsets of land tiles. He said the problems he anticipates will likely fall into one of three categories: (1) product (output) and input science data sets, and metadata, (2) vegetation index science issues, and (3) software change issues. His planned paths of action based upon QA results are: (1) set science quality flag, and (2)

set science quality flag explanation, etc. He showed the vegetation index QA scenario flow diagram. Re QA issues and plans, he will continue QA on Level 2g, and aggregate N-days. He said there is need for communications with the LDOPE on how to set science quality flags. Also, there is an issue regarding MODAGG QA science quality flag updates. Roy suggested that Van Leeuwen needs to look at Level 2 products because it seems he is concentrating mostly on Level 3 products.

- Joe Glassy said his QA plan has been stable for more than year. Petr Votava will do daily product QA and Glassy will do 8-day product QA. The goal is to do QA on 5% of MOD15A2 products. He said QA will emphasize final assignment of the science quality flag. He discussed SCF next steps at the University of Montana. Glassy plans to use concurrent FTP, and take the best throughput he can get. He is preparing global reference sets now for FPAR, LAI, & PSN. He will coordinate with Arizona and Boston on MOD_PRAGG QA. He also plans on doing more operations rehearsals and put SCS ops plan on Web. Vermote said regarding transfer, Glassy needs to coordinate the pull of data. Justice added that there needs to be a proposed approach for handling this. Vermote wants to know numbers on the demands that will be placed on the system.

- Louis Giglio presented the MODIS Fire Product QA Update. He said the plan has been stable for the last few months. The planned early products consist of Level 2, 2G, Level 3, daily (1 km), 8-day (1 km), and 16-day (1 km). Each fire product assigns the following pixel classes: fire (low, nominal, or high-confidence), unknown, non-fire, cloud, water, or missing data. Giglio said the anticipated fire product quality-related problems include the algorithm (such as the inability to detect small/cool fires, false alarms from sub-pixel clouds, etc.). There could also be problems with upstream products. The worst-case volume estimate for a single Level 2 granule is 755 MB. Since the last Science Team meeting, Giglio has worked on developing product-specific QA tools. He has a Level 2 granule inspector to examine the Level 2 fire product to identify contiguous fire pixel blobs. He is currently prototyping using AVHRR data because the available MODIS synthetic data is not realistic in terms of the shapes and sizes of the fire pixels. He has a QA metadata summarizer that takes metadata from any number of fire products and summarizes them in tabular form. This metadata summary enables quick, coarse-level QA that allows him to assess up to 1000 scenes at one time. He also has an automatic Level 2 QA metadata inspector that examines the Level 2 fire product metadata for consistency and, if it finds a problem, sends problem report e-mails to multiple recipients. Then, there is a Level 3 QA metadata inspector that examines Level 3 metadata for consistency using seasonal functions. During post-launch, Giglio will do short-term QA via periodic adjustments of the fire product algorithm and/or production code,

and by fine tuning his inspection programs. He also plans to build a fire product evaluation catalog. Over the long-term, he hopes there will be few if any major algorithm or production code adjustments.

- Dorothy Hall reported on her team's plans for QA of the MODIS snow and ice products. Regarding QA validation, Hall's team is now working with NOAA and NORSC in Minnesota, as well as NOAA / NESDIS personnel. Hall said she is comparing the MODIS snow and ice products with theirs. QA assessment of products and monitoring of selected geographic areas are her team's main activities. They will be looking at 5 tiles per day.

- Crystal Schaaf, of Boston University, reported on the MODIS BRDF / Albedo product. She said she is checking obvious errors flagged by the LDOPE. Regarding "golden tiles," her team has developed many QA flags. She feels the most significant problem now is how much room the product QA metadata have in the QA database. Her team is addressing that problem now. Currently, MODAGG is their only input. Schaaf said their algorithm drops and "obvious" outliers, so their main effort now is examining their golden tiles to look for outliers. She also plans to explore BRDF inversions with respect to sampling and land cover constraints. Roy said it is difficult to do QA on a BRDF inversion, perhaps impossible.

- Schaaf also reported on the MODIS Land Cover product. She said that tests and training were done at the SCF because MOD12 is a handcrafted product. Thus, its QA flags were set manually per tile according to the test and training. On a per pixel basis, QA simply determines whether a pixel has been updated or not. Schaaf will monitor the MOD12 interim product during the test and training period. She said she doesn't understand the process for MOD12—twelve months worth of data will be processed every 3 months, not quarterly.

- Rob Sohlberg, University of Maryland, reported on the MODIS Vegetative Cover conversion product. He told the Group that he installed added computing capacity to the SCF. He has successfully tested the MEBDOS ordering interface and current network performance capabilities. Sohlberg is using NOeSYS Vis Pro to manipulate HDF data. Regarding early QA & validation activities, his focus is on test areas and EOS core sites. His activities involve examining a range of soils and anthropogenic conditions. He plans to use Landsat and commercial high-resolution data as "truth," and he will also look at the global distribution of detected change. Sohlberg said many tiles may fail QA as the look-up tables are adjusted. He anticipates participating in some local field activities. Early on, he will provide science data input during the geolocation shake-out period. Then he will begin running Level 2G version of the vegetative cover conversion code at the

UMD-SCF. After that, Sohlberg will apply QA procedures and begin revising the look-up tables based on early MODIS data. He plans to produce 250-m image pairs showing dramatic change events. He will deliver a post-launch version of a vegetative cover change (VCC) product. He noted that the VCC program runs every month, but it looks at the last 3 months and the last year, so it requires at least 4 months of data. Sohlberg has a new data collector (MOD44C) that creates 32-day composites. He anticipates regular production of 6-12 tiles at the UMD-SCF. Results will be made available through the Global Land Cover Facility. Wolfe added that SDST has subsets of the Global Land Cover data sets.

1.8 New MODLAND Action Items

1. MODLAND SCFs — provide the LDOPE lists of upstream products and what SDS names in those upstream products are used to make your at-launch products. Also, provide LDOPE with volume estimate of your products.
2. MODLAND PIs — Select some "Golden Tiles" (an area where you want to know your algorithm is stable and where the site is well characterized)
3. MODLAND PIs — Continue / begin to perform QA assessments on products produced under PI Processing N-day, X-Day, and Y-Day tests.
4. Nazmi El Saleous, Bob Wolfe, & Mike Linda — render MODAPS production information more "obvious" on web. To determine data quality, users need to know how a given product was made.
5. MODAPS — work production issues related to QA, both operational issues and failed PGE handling.
6. DAAC User Services Working Group — provide user quality feedback to the LDOPE.
7. Zhengming Wan to show more details about his QA plans at the next MODLAND Meeting.
8. SDST — Organize a cross-discipline allocation discussion with internal MODIS management so the Team can decide upon the timing of when folks can access system, and who gets data and when, in the early post-launch period.
9. R. Wolfe — space allocation at GSFC is an issue. There needs to be workspace for visiting scientists to come to GSFC in September 1999 to work through Level 1b processing and geolocation issues. Wolfe will produce a strawman plan on meeting space and workstation requirements.
10. D. Roy —most of the MODIS SCFs have not obtained data sets from the MODIS N-Day test. Yet between now and launch, much emphasis will be placed on examining those data. There is concern that there is a gap between the SCFs and the LDOPE. Hence, Roy took an action to coordinate who will perform QA assessments on MODAPS.
11. MODLAND? — Justice feels the Group has a real data management problem. For QA and time-series analyses, each PI needs a more detailed plan of approach.

12. MODLAND — provide feedback to Robert Wolfe, Jeff Privette, and David Roy if and when you plan to participate in any validation or QA campaigns.

MODIS Atmosphere Discipline Group Meeting
6 May 1999

Michael King chaired the meeting and David Herring recorded these minutes.

1.0 Software Development and Testing

1.1 PGE Update Schedule

Rich Hucek, of SDST, presented the PGE update schedule. He said he plans to update PGE03 on May 27 with science and ancillary data. Hucek also plans to have PGE06 done by the end of May, because he wants PGE06 included in the upcoming Mission Operation Science System-2 (MOSS-2) test scheduled for the first week in June. Science and metadata will be updated; metadata requires a lot of work. For PGE69, the code is done, however it needs testing. He does not know when testing will be done. PE56 code is done and delivered. Neither was part of the N-day test.

Strabala asked about removing the cloud mask and creating a separate PGE and about volcano alert. Hucek replied that they have only recently begun talking about that issue. Strabala asked about how to ensure that Level 3 tiling and daily aggregates get into the N-day test. Hucek said he needs to talk to Ed Masuoka about that; it has never been operationally tested.

Regarding PGE57, the code is finished, but does not include scripts to allow it to run in the MODAPS environment yet. SDST anticipates resolving this problem by mid-June. PGE70 is a replica of monthly code, but it temporally aggregates over 7 days. PGE55, Clear Sky Radiance (CSR), is still being considered and may not be implemented at launch. This code takes clear scenes from the MODIS cloud mask and writes the file to a granule. It is then integrated into the daily global composite. Time series data are used by the cloud mask and cloud product to better determine clear scenes.

Ackerman said that although CSR would improve the cloud mask, it can run without it. CSR is necessary in order to do CO_2 slicing for cloud top properties. Strabala said CSR is wanted, but probably not critical. Hucek said the challenge is to get PGE03 and the cloud product done by the end of May. All of the Atmosphere Group's Level 2 code and the first part of Level 3 are ready for delivery. King noted that the cloud mask is causing breakage in the code that was not expected. Jason Li is working on that issue now.

Regarding resource allocation, Hucek said that SDST does more than Atmosphere PGEs. Until recently, SDST handled integration and standards checks on all product codes. The MODIS Ocean Group did Level 1A, MODLAND did standards checks on Level 1B, and SDST did geolocation.

Currently, MCST delivers its code directly to the GDAAC and Hucek needs to switch geolocation over to the GDAAC.

King said he wants to be sure that the Atmosphere Group gets through all its PGEs. He asked Hucek to request SDST to produce a new Level 1B PGE product at Global Area Coverage (GAC) resolution. Masuoka said that that resolution reduces volume.

Bruce Guenther suggested that the Atmosphere Group might need to choose how it subsamples. He proferred that that is an SDST job because SDST does all subsampling. Guenther asked if the GDAAC has any subsampling capability. King replied that they implement and run Level 1B code, but do not do any coding; the GDAAC does not work with code. Only subsetting may be done in the future. The GDAAC plans to receive data and subset for particular actions. Guenther took an action item to discuss this issue with the GDAAC to see if there are ways to resolve this issue.

Yoram Kaufman commented that the Group should focus on a date for updates of algorithms and asked for clarification on the policy for upgrades after launch. Hucek said that he did not prepare anything in his presentation on that topic. He noted that SDST is there to tweak code "on the fly." If this tweaking involves a large amount of code, then SDST must also do a standards check. But if it is changing a few symbols, then could do that and implement the changes quickly. Kaufman suggested that someone is needed to characterize this process. Bill Ridgway said that if a given change involves code that is downstream in the product list, integration goes pretty fast. However, for something upstream like the cloud mask, SDST will do much testing before making any changes.

1.2 CPU Performance Statistics (from the N-Day test)

Hucek said SDST tracked CPU and wall clock time and averaged this information for day and night modes. PGE04 runs at half-real-time. SDST found that it takes 5.5 times longer to run the cloud mask than it does to process the data. It takes 3.3 times longer to run the optical depth product than to process the data. In short, SDST finds that CPU time is not a good representation of wall clock time.

Paul Menzel asked if there are no further optimizations, does SDST have a problem? Considerable discussion followed this question on the time required to process the MODIS cloud mask and possible ways to optimize the code.

1.3 Level 3 Testing and Integration

Paul Hubanks distributed a summary sheet on MOD08 that gives an overview of the products it contains. He briefly summarized the history of the development of this software. He said the process was to write generalized code whereby

logic decisions were determined by the file specs. The original code was designed by Robert Pincus.

Hubanks listed Level 3 HDF Product Sizes. A tile equals 13 MB. He listed sample testing and integration problems. Hubanks reported that there are a few truncated SDS names pinpointing a bug in HDF 4.1 release 1; these were corrected in release 2. In short, he had to change from standardized SDS names to shorter ones. Also, there were problems running monthly aggregate code after using a new compiler that have been resolved.

His planned testing includes running tile code for all 36 tiles and running daily code using N-day test data. This information will be used as input into the daily code and then examined based upon the output from the SDS's. For 2nd day of data, he plans to do better (but not rigorous) testing of weekly and monthly code. Ridgway pointed out that there probably would be a lot of missing granules. He asked if the averages have meaning if there are a lot of missing data? Hucek said he doesn't anticipate many of those types of problems showing up.

Strabala asked if the Atmosphere Group could still add some parameters. Hubanks said yes, as long as they are within the structure of what we're doing, and as long as they have similar statistics to what we're already computing.

2.0 Data Processing and Post-Launch Evaluation

2.1 MODAPS Processing and Production rules

Hucek listed the Level 2 Production Rules summary with optional and required products. Steve Ackerman said there is some confusion about what "optional" means. He said it doesn't mean that quality goes down because something is not there. If we don't have precipitable water vapor, for example, we can still produce a good product. Hucek concurred, stating that products can run and will be archived even if certain others are not there.

It was pointed out that SDST should tweak its production rules to accommodate the availability of ancillary data. Hucek said the at-launch system doesn't have a pre-set "wait" time. Steve Platnick pointed out that if the wait time is not right, we could have a situation where the system never processes a given ancillary data product. King said this could negatively impact the cloud mask, for instance.

Regarding the Level 3 rules summary, Hucek said that to run tiling code on a daily basis, SDST needs to have all Level 2 inputs available. The tiling process rules are the same for daily / weekly / monthly averaging.

2.2 Clear Sky Radiance Processing

PGE03 runs at the GDAAC. This executable takes MODCSR_G and passes this information back to MODAPS, where it is input into PGE55. Then the information is passed back, as an 8-day composite for bands 31-36, to the GDAAC as an ancillary file. Wisconsin wants this 8-day composite. Hucek said the Group must decide whether it wants to run PGE55 in the GDAAC or MODAPS. Originally, he felt if the Atmosphere Group wants to test and tweak this PGE, it should run in MODAPS; but now he's not sure. The Group may want to run it in the GDAAC.

Hucek listed SDST's processing requirements for CSR. The PGE55 shall run once per day and produce 8-day composite file spanning on consecutive days and terminating on current data days. Also, the number of file inputs to the PGE55 compositor shouldn't exceed system capabilities. The same 8-day composite file shall be used to process all granules of PGE03 for a specified UTC data day. The requirements are implemented by constructing 8-day composite files from daily files. The end date of the 8-day composite file is used to process not next the day, but for lags at the start of a data day by 24 hours, which is a variable design parameter.

Regarding production issues—SDST is reconfiguring PGE03. The plan is to group processes that use similar ancillary data into PGEs at that time. If any processes within the PGE fail, the PGE itself is flagged as a failure and no products from it get archived. Hucek feels this is important, so SDST is reconfiguring it to make each separate product (MODPR35, 07, and PRVOLC) as three separate PGEs. He noted that the 50% production rule affects only PGE06; the PGE03 and 04 will run at 1x. Hucek took an action item to write a CCR (Configuration Change Request) within SDST to be reviewed by Ed Masuoka and the systems analyst.

King said 50% isn't a rule, but a strategy based on how much capability we have at launch. It looks like the Atmosphere Group can do all its products at Level1. In fact, it doesn't seem like it will be impossible to do 100% of Atmosphere's products. He noted that the science team would be required to explain to the science community how much MODIS data it can produce at launch. Hucek noted that the GDAAC could only archive 20-30% of the Atmosphere Group's products. His point was that there is some limitation and therefore the Group must select which granules it wishes to archive. King responded that the GDAAC archive is for the outside community. He doesn't know how much MODAPS can archive. He feels it's important that Atmosphere can archive in the GDAAC some significant granules of orbits and days so that it can test file readers, etc. King said we must be sure we have 10% of volume for each data product. He expects the Group will be fully reprocessing all of them later. Kaufman added that archiving 100% of the data at Level 3 is very important.

2.3 Windhoek Processing Facility

Bill Ridgway presented an overview of the Windhoek Processing Facility, which was established to make QA and product distribution among the Atmosphere Group members much easier.

Regarding Atmosphere data flow overflow, Ridgway said some data processing was broken out of the GDAAC into MODAPS and then routed back to the GDAAC. Windhoek is really part of MODAPS processing environment (with the same computer hardware, the same network, same data archive, etc.).

Ridgway noted that the DAACs are interested in creating browse image products. The Atmosphere Group may do that in MODAPS and ship the images back to the DAACs—it is up to the PIs.

The Windhoek Facility has an 8-processor SGI Origin 2000, as well as 300-600 GB of on-line storage with limited tape archival capabilities. If there is any data subsetting that MODAPS cannot do, the Group should consider doing it at Windhoek because the network connections are there. Ridgway noted that Atmosphere has the software so the Group can do its own testing, and it can re-run PGEs. He also noted that Liam Gumley has some custom visualization software that he intends to have available at launch.

A. K. Sharma asked how QA will be done and how that information will be fed back to the GDAAC. King said the Group hasn't really dealt with that issue and currently has no mechanism for doing it. Ridgway said the GDAAC should set up Web pages to make the process easier. If there are no tools at the GDAAC end, he doesn't see how Atmosphere can easily do QA. Sharma agreed that a Web interface is a good idea. Kaufman feels the Group should follow MODLAND's lead and hire someone to work that issue. MODLAND has David Roy; Atmosphere needs someone with similar experience and expertise.

Regarding PGE updates and testing, the Windhoek Facility will supplement MODIS SDST integration efforts. It will prepare a PGE testing environment for rapid turnaround of images. King said he doesn't want to send browse products for data that are not in the archive.

Regarding production data subsetting, Windhoek will tag "special" granules and extract data from them; e.g., over validation sites like ARM, AERONET, etc. Kaufman asked who would do the programming for this activity? Kaufman also said the activity should include field campaigns, like SCAR99 and SAFARI. If possible, it would be useful to play with Level 2 and Level 3 data simultaneously. Ridgway asked should the Group re-grid or use raw granules?

Ridgway listed special issues he feels the Group must address:
(1) resolving QA issues that impact downstream products; i.e., cloud mask, profiles, aerosol products. Menzel asked where should people be working? At the GDAAC or at Windhoek? He said he needs to know so he can start planning for workspace. Hucek said the activity should probably be done at Windhoek. Menzel said that 2-3 people from the University of Wisconsin plan to come here and work on QA for about 2 weeks.

3.0 DAAC Distribution and Plans

3.1 GDAAC Reports

Chris Lynnes reported that the Science Investigator-led Processing System (SIPS) interface is scheduled to coincide with Drop 5A. At that point, the SIPS data coming in from interface will be ready. He said Drop 5A would be operational after the activation and evaluation period. The GDAAC needs to be able to test 5A while operating under launch mode software. In the meantime, it is possible to manually insert data into the data server, but this is only possible for a few granules. Lynnes said the bottom line is prioritizing the mission-critical stuff. The GDAAC is also working on a system to handle higher-level data product distribution. Their approach is to clone the Version 0 archive and distribution system. At a minimum, the GDAAC can process 40 GB of data per day at ingest.

Lynnes listed the responsibilities of the ACDIS (AM-1 Contingency Data and Information System). He said there are a number of constraints on the ACDIS: mainly that it has been given minimal budget and so Lynnes assumes that the GDAAC must emulate an ECS style interface so it is transparent to the MODAPS interface. He said that since the GDAAC already has the ACDIS, with minimal modifications it could satisfy additional requirements as well. Another available resource is the MCST router. If the Group can hook the MODAPS system to that, it could add throughput to the system. Lynnes said the basic design is already in acceptance testing and the overall Implementation Plan has been developed.

Lynnes told the Group that browse products would be done at the GDAAC purely as ordering aid—analogous to pictures in a catalog. He said this is c*ritical* to preventing spurious requests (preserves throughput and makes users happy when they get what they think they're asking for). These browse products will not be used for science, quality assurance, or public relations. Regarding characteristics of the browse images, they will be HDF files with raster images, not science data sets. There will be less than or equal to one browse file per data granule. A challenge will be linking to data granules through the SIPS interface.

Regarding QA and metadata, the GDAAC will send selected data to the Atmosphere SCF (~10%), primarily by standing order or subscription. There is

some discrepancy between ESDIS' baseline and the MODIS Science Team's requirements. Lynnes said the updates to QA flags would be e-mailed from the SCF to the GDAAC. There is now some difference between GDAAC-produced products and those from the SCF. For instance, data sent from MODAPS to the SCF has no Universal Reference (UR) yet, but QA-MUT works off UR's.

3.2 Atmosphere Group Web Sites

Paul Hubanks solicited feedback on the desired content for a MODIS Atmosphere Group Web site. The site will contain an overview of the Group's data products, links to product sites, status updates (instrument, DAAC processing, algorithms, products, etc.), news and agendas regarding upcoming meetings and events, staff functions and contact information, software archive & distribution, details on image visualization tools, software development schedules, sample data product imagery (the "best of the best"), and a bulletin board to facilitate discussion and resolution of issues. Hubanks showed some early sample designs of what the new page will look like.

3.3 Level 3 Equal Area Grid

Michael King presented an overview of the equal angle grid approach to data visualization, originally suggested by Dave Randall. King noted that Global Climate Models typically use either a grid point model (1°x1° equal angle grid) or a spectral model (no models are entirely spectral). King showed the construction of icosahedral grids with 12 vertices that were subdivided into triangles, and that could continue to be subdivided into many smaller triangles with no knowledge of poles (as happens in other gridding approaches). King showed a surface topography map in this grid projection with no singularity at poles. He said the goal is to produce gridded, time-averaged atmosphere products at daily, 8-day, and monthly temporal resolution. Future enhancements include wavelet transform for spatial patterns of atmosphere parameters within each grid cell. King said Dave Randall would provide MODIS with the grid mapping software for putting data into the cells of this grid. He showed a current grid model with the singularities at the poles, in contrast with the geodesic model—the latter was more realistic with no singularity. When binning up MODIS atmosphere products, King said the Group could save data and statistics in this grid. He feels this will also serve as a natural input format into one GCM modeling group, and will likely be the future direction of general circulation modeling. Bo-Cai Gao pointed out that not many people are using this grid, so the approach could cause problems for users of MODIS data. King responded that Atmosphere would not do this at the exclusion of other gridding approaches. For instance, MODIS will still use an equal angle grid.

3.4 Winter Experiment (WINTEX) March 1999

Chris Moeller presented an update on the WINTEX campaign. Eight ER-2 flights were flown to collect MAS, NAST, and S-HIS data. The science goal was to do

MODIS cloud mask testing and calibration. Moeller said detailed information on the campaign could be found on the University of Wisconsin home page. The site contains a detailed list of science objectives.

3.5 Discussion And Updates On MODIS Reprocessing, Product Release, Decision-Making

King reported that Claire Parkinson is moving forward on producing Volume 2 of the EOS Data Products Handbook. Can reproduce where applicable. If anyone wants to update their product descriptions they should send her the new descriptions.

Regarding the first release of products after launch, King noted that there is ongoing discussion on timing issues. Yoram said the Group should wait 60 days, assuming there are no "blunders." There was some discussion about QA and checking data versus releasing them through the GDAAC. King said once MODIS data are in the GDAAC, the Group cannot control distribution on that end. Ridgway said the GDAAC is asking for QA tags on data in the early days after launch so that users will know the status of those data products. King said he wants to encourage intercomparisons and analyses to uncover problems; yet he wants to discourage comparisons with other instruments until the MODIS data are initialized.

King said the Atmosphere Group needs to specify coding errors and corrections before their data go to the GDAAC. Yoram feels this activity should be done at or before day 150 after launch. If nothing is found to be wrong with the data at that time, the Group will release its data products. Lorraine asked (1) if the Group finds something wrong with the data on day 150, can we fix the problem by day 210? She feels this is a major concern. Hucek said this is not a problem.

Yoram said the MODIS Science Team needs be sure its data are good before release, without seeming like it is hoarding the data. King proposed developing a prioritized phasing of when to make its data available. There was a lively discussion about how to strike a balance between releasing data to the science community in a timely manner, yet taking the time and effort to make sure that the data are valid and test for quality assurance. On other hand, King said that getting data out quickly would enable the community to provide constructive feedback to help the Group correct its data so that they can be reprocessed more accurately and more quickly.

King observed that the MODIS Direct Broadcast signal would be turned off initially after launch. He does not want to release MODIS data until the Terra project scientist says they are ready for release.

Regarding an HDF browse facility, King said no one is currently working on that issue. Hucek took an action item to check on that. Kaufman asked King to designate someone to work on QA for the Atmosphere Group.

3.6 Practical Method to Derive AVHRR-consistent NDVI Data Series from Narrow-channel MODIS data

Bo-Cai Gao told the Group that the MODIS NDVI product would have a much shorter lifetime span with two MODIS instruments. For climate studies, a longer time series of that data product is needed. He showed the geophysical definition of NDVI.

Gao has developed a technique for creating similar AVHRR-consistent NDVI values using several of MODIS' narrow channels. The broad AHVRR red channel (0.58 – 0.68 µm) is similar to using the narrow MODIS green and red channels. The broad AVHRR NIR channel (0.73-1.0 µm) is similar to using the narrow MODIS NIR channel (0.841-0.876 µm) and the water vapor absorption channel (0.915-0.965 µm). Gao said his method has been successfully tested using AVIRIS data sets acquired under humid and dry atmospheric conditions.

4.0 Remote Sensing of Cloud Properties using MAS Data: Cloud Thermodynamic Phase – by Bryan Baum –

Bryan Baum has developed a new radiative transfer model. His approach for atmosphere absorption modeling was done using sonde profiles from the SUCCESS campaign, correlated with the k-distribution technique developed by Kratz in 1995. Baum said that, in his approach, ice phase clouds are modeled as a mixture of bullet rosettes, hexagonal plates, hollow columns and aggregates (at air temperatures ranging from -55°C through –35°C). Baum is developing a lookup table for cirrus properties.

Regarding cloud thermodynamic phase, the baseline algorithms for MODIS involves the 8.52-, 11-, and 12-µm channels to determine phase (IR trispectral algorithms). The infrared trispectral algorithm was designed for scenes with single-phase clouds.

In summary, Baum suggested that for daytime processing, the Group could incorporate extra channels in the VIS / NIR region that will improve determination of cloud phase; particularly in cloud overlap and single-layered mixed phase cloudy scenes. He feels this approach can ultimately improve cloud phase determination in the daytime without using lookup tables.

5.0 Action Items

1. Bruce Guenther took an action item to discuss the issue of subsetting with the GDAAC and report back to the Atmosphere Group.
2. Rick Hucek took an action item to write a CCR (Configuration Change Request) for PGE03 within SDST to be reviewed by Ed Masuoka and the systems analyst.
3. Rich Hucek to check on GDAAC plans for a Web-based HDF browse facility and report back to the Atmosphere Group.
4. Michael King to designate someone to work on QA for the Atmosphere Group.